Chemical Mapping of Vesta and Ceres

AUTHORS (FIRST NAME, LAST NAME): Thomas H Prettyman1, David W Mittlefehldt2, Naoyuki Yamashita1, Harry Y McSween3, William C Feldman1, David J Lawrence4, Andrew W Beck5, Timothy J McCoy5, Michael J Toplis6, Hugau Mizzon6, Carol A Raymond7, Christopher T Russell8 INSTITUTIONS (ALL): 1. Planetary Science Institute, Albuquerque, NM, United States.
2. NASA Johnson Space Center, Houston, TX, United States.
3. University of Tennessee, Knoxville, TN, United States.
4. Johns Hopkins University Applied Physics Laboratory, Laurel, MD, United States.
5. Smithsonian Institution, Washington, DC, United States.
6. CNRS-Universite de Toulouse, Toulouse, France.
7. Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, United States.
8. University of California Los Angeles, Los Angeles, CA, United States.

ABSTRACT BODY: Following successful science operations at Vesta, the Dawn spacecraft is headed for an encounter with Ceres in 2015. What have we learned at Vesta? And, what do we expect to learn by comparing Vesta and Ceres? We will address these questions from the standpoint of geochemistry. Dawn's Gamma Ray and Neutron Detector (GRaND) is sensitive to the elemental composition of surface materials to depths of a few decimeters [1]. Gamma rays and neutrons, produced by the steady bombardment of galactic cosmic rays and by the decay of naturally-occurring radioisotopes (K, Th, U), provide a chemical fingerprint of the regolith. Analysis of planetary radiation emissions enables mapping of specific elements (such as Fe, Mg, Si, Cl, and H) and compositional parameters (such as average atomic mass), which provide information about processes that shaped the planet's surface and interior. Dawn has exceeded operational goals for GRaND at Vesta, accumulating an abundance of nadir-pointed data during five months in a 210 km, low altitude mapping orbit around Vesta (265-km mean radius). Chemical information from gamma ray and neutron measurements was used to test the connection between Vesta and the howardite, eucrite, and diogenite (HED) meteorites [2]. Additionally, GRaND searched for evolved, igneous lithologies [3], mantle and upper crustal materials exposed in large impact basins, mesosiderite compositions, and hydrogen in Vesta's bulk regolith. Results of our analyses and their implications for thermal evolution and regolith-processes will be presented.
The possibility of a subcrustal ocean [4, 5] and lack of cerean meteorites makes water-rich Ceres a compelling target of exploration [6].
If Ceres underwent aqueous differentiation, then crustal overturn or gas driven volcanism may have significantly modified its primitive surface; and products of aqueous alteration (e.g. [7]) would detectable by GRaND [1]. For example, the presence of Cl in salts, associated with liquid-water-processes, would have a profound effect on the thermal neutron leakage flux. GRaND is sensitive to H and H-layering, which may be in the form of endogenic water ice or hydrous minerals on Ceres. Ammonia ice (e.g., from recent cryovolcanism) would produce a distinctly different neutron signature than water ice [1]. Prospective results for GRaND at Ceres will be presented in the context of what we have learned about Vesta.

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